UPGRADING OLDER FLUE GAS DESULFURIZATION SYSTEMS

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ABSTRACT

Flue gas desulfurization (FGD) systems usually have a significantly shorter life span than other major systems in a power plant. FGD systems tend to require improvements or repairs within a relatively short time (by power plant standards) after startup. These improvements could be as simple as replacing duct linings or as involved as a complete overhaul of major equipment. The scope of upgrading depends on the condition of the FGD system and the owner's goals. An upgrade project can be modest and inexpensive, or it can encompass the entire FGD system, be quite costly, and require a detailed work schedule.

The size of the project determines the procedure for its execution, but some basic steps should be followed in most cases:

- Assess the FGD system's present condition
- Select areas to upgrade
- Carry out the upgrade strategy

Selecting areas to upgrade depends on detailed analyses of technical and economic feasibility. Developing and implementing an upgrade strategy requires thorough advanced planning and coordination among power production, operations and maintenance, purchasing, scheduling, and other plant groups. A well-prepared upgrade project with realistic goals can result in improved availability, performance, and lower costs for an FGD system.

INTRODUCTION

The aging characteristics of power plant systems (such as boiler, turbine, and generator) can be accurately predicted, based on years of experience at many power plants. However, there is little long-term data that can be applied to FGD systems because the technology is only now beginning to mature. Consequently, there are still areas of uncertainty concerning the life expectancy of FGD equipment. This is further complicated by the many different technologies, vendor designs, and operating conditions. Most FGD systems are subjected to severe service conditions that cause corrosion and erosion and induce early equipment failure. In a relatively short time after startup, the owner may be faced with major decisions regarding operation of the FGD system, including whether or not to upgrade the system.

The term "upgrading" used in this paper encompasses a variety of programs, including process improvement or enhancement, system betterment, and life extension. In addition to system age, there are a number of other factors that may lead to upgrading an FGD system:

- <u>FGD Equipment Failures.</u> The FGD system may be inadequate or, in some cases, literally falling apart. As the result of poor design and/or improper operations and maintenance, the FGD system may suffer widespread mechanical, electrical, or structural failures.

- Change in Fuel. Because of economic incentives for burning high sulfur coals, changes to the FGD system (such as increased reagent storage and preparation and waste treatment capacity) may be needed.

- Desire to Optimize. Process improvements that reduce operations and maintenance, major repairs, spare parts inventory, manpower, reagent consumption, and power use may result in substantial savings.

- Improved Technologies. As FGD technologies improve and more experience is gained, major changes to an existing FGD process may be advantageous.

- Changes in Load. Because of the changing demand for power in the U.S., a power plant may have an FGD system that was designed for base-load, but is now used for cycling service. Such an FGD system may be unable to meet the quick start and stop needs of a cycling plant.

- Improved Availability and Reliability. High FGD system availability and reliability can help meet environmental regulations (thereby avoiding fines for noncompliance) and reduce maintenance repair costs.

- Improved Sulfur Dioxide Removal Efficiency. An FGD system that has trouble meeting emission limits can be improved in a number of ways, such as installing an organic acid additive system.

The different upgrade strategies depend on the owner's needs, as well as the original FGD design and history of operation. Upgrade projects may be as simple as a new program of improved operations and maintenance or as extensive as investing in new equipment. Further, upgrading may be carried out as a number of small projects spread out over time or as one large project.

Since an FGD system does not contribute to power production, the decision to spend money on upgrading is not an easy one. In some cases, the problem originally arose because of lack of funding to purchase an adequate FGD system or to operate it properly. It is essential to obtain management's commitment to any FGD system upgrade projects at an early stage.

ASSESSING AN EXISTING FGD SYSTEM

Once the need for FGD system upgrading has been established and managerial support has been received, the existing condition of the system must be assessed. To conduct an assessment properly, it is important to first obtain all pertinent data, such as engineering documents, drawings, operating manuals and logs, and maintenance records.

Among the many questions to be answered by the assessment are the following:

- Is the system operating and performing as it was designed?

- Can the upgrade requirements be met with the current FGD design?

- Can the upgrade requirements be met with improved operating, inspection, and maintenance procedures?

- Are major equipment and/or process changes required?

- Has the condition of the system deteriorated from corrosion and erosion to the point that major upgrade work is required?

Many FGD system upgrade projects require the purchase of new equipment; however, because of the large capital investment involved, answers to the following questions should first be considered.

- Is the equipment the root cause of the problem or just a symptom of out-of-control process conditions?

- Can the problem be solved by equipment currently available at the site?

- Is the equipment downtime normal for FGD systems?

An FGD system should be assessed or evaluated by a committee with representation from the engineering, operating, and maintenance departments. Adequate staffing should be provided to support the heavy data collection and analysis requirements. Some of the tasks to be performed by the assessment commitee include the following:

- Review the existing FGD system design and equipment with respect to finding candidates for upgrading. Flow schematics, material balances, piping and instrumentation diagrams (P&ID), equipment layout, piping, equipment data sheets, material data sheets, and operating conditions are among the items to be reviewed.

- Determine system operating conditions, preferably including some nighttime coverage. Sufficient operating performance and analytical data should be obtained to establish baseline conditions for the system. These values should be compared to the system design conditions to find deficiencies.

- Establish the operating and maintenance history of the system from power plant and FGD system records to find areas with operating problems or unusually high maintenance.

Process, equipment, material, and operations and maintenance deficiencies should be identified as candidates for upgrading. Upgrade requirements can be classified according to the work that should be done, including installation of new equipment, improvements in operating and maintenance procedures, and significant process revisions.

SELECTING AREAS TO UPGRADE

After candidate areas for upgrade have been identified, technical and economic evaluations should be performed to select the most appropriate areas for upgrading.

Technical Evaluation

The importance of evaluating technical feasibility before upgrade projects are started cannot be overstated, even though it may be obvious in retrospect. The technical feasibility of a particular upgrade project comes directly from the assessment of the present condition of an FGD system.

Structural integrity, for example, must be verified before any large mechanical equipment is installed at elevations above grade. In older FGD systems, corrosion may have significantly weakened structures. Verification of structural integrity is particularly important for isolation damper replacements, because repair of support steel may have to be included in the cost of damper replacement.

There are several areas of process upgrades where technical feasibility must be verified. In the case of a slurry pump, resistance to slurry flow should not be so high that it is limiting; it may be desirable to modify a piping system rather than to replace or to speed up a pump. Velocity in slurry pipes should be checked and kept relatively low to minimize erosion of pipes, yet not so low that slurry solids drop out of suspension.

Technical feasibility also should be assessed prior to instrumentation upgrades. If the need to upgrade is caused by an excessively harsh operating environment (e.g., high temperature and humidity inside an enclosure or over the top of a flue gas duct), relocation of instruments may be more feasible than the purchase of more rugged equipment.

Another factor to consider when replacing equipment is whether there is adequate room for equipment installation, removal, and maintenance.

Economic Evaluation

After technically assessing and selecting the areas to be upgraded, the costs of projects must be considered. Although all of the selected upgrade projects may be worthy of consideration, it would be most unusual for management to fund all of them.

It is important to establish all of the economic evaluation factors. These factors include interest rates, escalation, reagent costs, and utility costs (water, steam, electricity) which should be specific for the FGD system and should also be consistent with other established criteria for the site.

A good basis for screening upgrade projects and ranking alternatives in areas to be upgraded is to evaluate costs versus benefits. Depending on the method of economic analysis, various projects have widely different capital costs as well as different operating costs. An accepted basis of comparison that can be used in a cost-benefit analysis is the present worth of revenue requirement in which capital, operating, maintenance, and other costs are evaluated on a common basis.

All quantifiable costs and benefits associated with a particular upgrade project should be included in the evaluation of cost versus benefit, even though they may not be immediately obvious. For example, if an upgrade project results in a significant reduction in reagent consumption (e.g., limestone), the savings (benefit) is not just the lower annual cost of limestone, but also the reduced waste sludge processing and handling costs. Also, reduced limestone grinding results in a lower rate of wear for ball mill liners (lower maintenance cost) and lower electrical power consumption for grinding stone.

Care should be taken, however, to also examine the areas where increased costs may be overlooked. For example, when sulfur dioxide removal is improved, limestone consumption actually increases (assuming that the stoichiometry is the same), resulting in increased limestone grinding and waste sludge handling costs.

An upgrade effort may be delayed because of budget constraints no matter how much it is needed or wanted. However, a realistic and logical presentation of the cost versus benefit evaluation is useful in demonstrating to management the bottom-line benefits of specific upgrade proposals.

All upgrade projects need not be expensive. A project may be as simple as ordering a better grade of replacement parts, such as more reliable pH probes. Also, recording observations of FGD system behavior as described in the operations and maintenance manuals may be an effective but inexpensive way to improve process operation and control.

Although it is difficult to assign a cost savings to personnel safety in an economic evaluation, safety should be considered an integral part of any upgrade effort. For example, a replacement damper at the outlet of a scrubber module should have seal air blowers and damper actuators in accessible locations, particularly if the originally installed platforms are inadequate. An added benefit of safety-related upgrade work is that it improves the morale of operators and maintenance personnel who must work around the various pieces of equipment. It also increases the likelihood that personnel will inspect equipment and observe its operation more frequently.

IMPLEMENTING UPGRADE PROJECTS

Implementing upgrade projects is similar to planning, designing, and procuring for new construction, but has additional constraints. At an early stage, a decision must be made whether to do some or all of the design work in-house or to contract it out. The roles of outside contractors, engineer/constructors, FGD vendors, and equipment manufacturers should be clearly defined. Frequently, mechanical design change work is awarded to the original contractor or manufacturer. Cost and expertise should always be considered.

When it is time to start the upgrade work, it is necessary to plan the general approach carefully by performing the following tasks:[1]

- Prepare a detailed project cost estimates and cash flow projections.
- Schedule work using a critical path or similar method. (Take advantage of planned outages or low load seasons when possible.)
- Define the needed work in terms of civil/structural, mechanical, electrical, and controls design requirements.
- Procure services and materials using specifications and clearly defined contract terms (minimize subcontracting).

The following are some of the unique concerns for upgrade projects that do not occur with new construction:

- Upgrade changes should be planned to interface with existing equipment and services.
- Because scheduling is critical, new equipment and materials must be available when needed.
- Upgrading should be planned keeping in mind the needs of an operating FGD system; for example, old dampers must be cut out of ductwork before new ones are installed, and the boiler must be shut down before old dampers can be cut out, etc.

- There should be adequate laydown areas for construction, as well as access for vehicles. Removal of old equipment should be carefully planned to minimize obstructions.

After upgrading has been completed, it is necessary to update manuals and drawings, retrain operations and maintenance personnel, inform other groups (such as security, accounting, laboratory) that new equipment is operating, and identify any needed changes in normal and emergency operating procedures.

CONCLUSIONS

Upgrading older FGD systems is done for a variety of reasons, specific to a site. It is prudent not to rush into upgrade projects without adequate study and evaluation of all options. A detailed assessment of the condition of the FGD system should be followed by selection of upgrade projects based on need, technical merit, and economic feasibility. Careful planning and implementation of upgrade projects are needed, and the requirements of the remainder of the power plant must be considered throughout the various stages of upgrading.

REFERENCES

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